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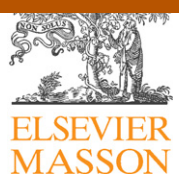

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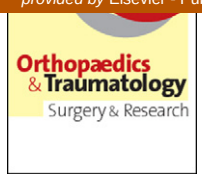

ORIGINAL ARTICLE

Is the trapezius transfer a useful treatment option for irreparable tears of the subscapularis?

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KEYWORDS
Trapezius transfer;
Irreparable subscapularis tear;
Functional and radiographic outcome

Summary
Introduction: When suture of the torn subscapularis could not be performed, a superior trapezius transfer was used for repair of the tendinous defect. The aim of this article is to report the mid-term functional and radiographic outcome of this technique when complete watertight rotator cuff healings were achieved and to investigate the usefulness of the trapezius transfer. The hypothesis of this work was that the trapezius transfer could not be considered as a useful treatment option.
Materials: The study included 20 shoulders demonstrating watertight healing of the rotator cuff on arthro CT-scan control performed 13.5 months after open surgery consisting of a trapezius transfer and suture of all other torn tendons. The mean age at surgery was 58.4 years. The trapezius transfer operative technique is described.
Methods: The functional status of the shoulders was assessed preoperatively and at a mean follow-up of 30 months according to the non-weighted Constant score and by measurement of active external rotation, arm at the side. Radiographic and CT-scan assessments were performed preoperatively and at a mean follow-up of 28.5 months. The functional results obtained at last follow-up were compared with those ''theoretically estimated'' after anatomically successful suture of the torn supra and infraspinatous without associated repair of the torn subscapularis.
Results: Between the pre- and postoperative periods, pain, daily activities and Constant score had all statistically improved. Arthritis was not aggravated but the preoperative anterior subluxation of the humeral head persisted in most cases. The reported Constant scores correlated those ''theoretically estimated'' in case of non-associated subscapularis repair.

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Discussion: This series is comparable to those evaluating the pectoralis major transfer technique and reports an identical functional outcome.
Conclusion: Since the Constant scores obtained after trapezius transfer correlate those estimated when not combining a subscapularis repair and taking into account the very frequent lack of improvement regarding the preoperative anterior subluxation of the humeral head, the trapezius transfer does not appear as a recommendable treatment option.
Level of evidence: Level IV retrospective study.

Introduction

Tears of the subscapularis were infrequently identified compared with those involving the supraspinatus and infraspinatus. The use of advanced techniques, analysis of arthrographies but also the development of arthro CT-scan have greatly improved the detection of subscapularis tendon tears [1].

Full-thickness rotator cuff tears involving the subscapularis tendon often lead to painful functional limitation. In case of isolated rupture of the subscapularis, the tendon-to-bone suture repair reports satisfactory mid-term results [2—4]. However, suture of the subscapularis may not always be achievable particularly when the fatty muscle degeneration reaches 2 or more [5]. In this case, transfer of the surrounding structures, such as the pectoralis major [6—11] has been proposed in the management of subscapularis tears. In the present case, a musculo-osteo-tendinous superior trapezius transfer was used [12,13]. Tendon harvest and insertion into the lesser tuberosity were easily achievable through the supraspinatous-transacromial-transdeltoid approach that we use quite systematically for suture of rotator cuff tears [14].

The purpose of this article was: (1) to provide the mid-term functional and radiographic results obtained in case of watertight repairs of rotator cuff tears by means of a trapezius transfer in the management of subscapularis tears and the suture without tension of all other torn cuff tendons but also (2): to assess the interest of the trapezius transfer technique. The hypothesis of that work was that the trapezius transfer technique was not a useful treatment option.

Material

This study included a series of 20 shoulders (20 operated patients, 14 males). These shoulders had a full-thickness rotator cuff tear often spread associated with an irreparable full-thickness rupture of the subscapularis in all cases. All rotator cuffs were watertight on arthro CT-scan evaluation performed at 13.5-month follow-up (standard deviation: ± 7.1 months, range, 7 to 38 months) after open surgery. The rotator cuff was considered watertight in the absence of leakage out of the joint and when the distal part of the trapezius transfer was visible on the anterior aspect of the lesser tuberosity (Fig. 1). A trapezius transfer was used in the management of irreparable tears of the subscapularis. All other torn tendons were sutured. The studied series was part of a continuous monocenter series including 25 rotator cuff tears which were repaired by means of a trapezius transfer over a 3-year period. Five shoulders demonstrating no watertight rotator cuff healing on arthro CT-scan control were excluded from the study.

Among the 20 shoulders included in the series, full-thickness ruptures of the subscapularis were complete in eight cases. These ruptures spread to the upper 2/3 of its humeral insertion in 10 cases and to the upper 1/3 in two cases. Tear of the subscapularis was isolated in three cases, associated with a full-thickness rupture of the supraspinatus in five cases (complete in four and affecting its anterior half in one) and associated with a full-thickness rupture of both the supraspinatus (complete tear) and infraspinatus (four complete ruptures and eight tears involving its upper 1/3) in 12 cases. The long head of the biceps was present in 17 cases. It was dislocated or subluxated in 10 cases, inflammatory in six and partially torn in four. Tendon repair had been performed at a mean age of 58.4 years with a standard deviation of ± 7.1 years and extremes from 48 to 70 years. Suture of the 17 tears of the supraspinatus and 12 tears of the infraspinatus required musculo-tendinous advancements in 15 and three cases respectively [14]. When present, the long head of the biceps was not resected. When dislocated, the long head of the biceps was replaced and maintained in place by means of the trapezius transfer.

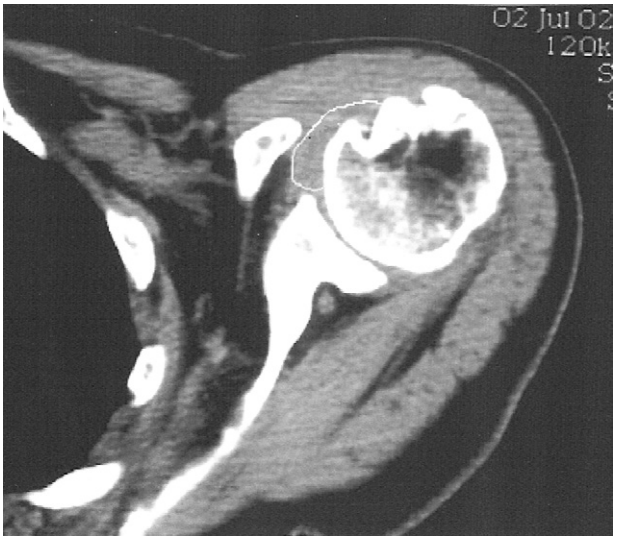

Figure 1 Insertion of the trapezius transfer in the lesser tuberosity (CT scan transversal slide). The trapezius fills the space between the humeral head and the coracoid process.

The trapezius transfer operative technique [14]

The patient is placed in a sitting or semi-sitting position. The whole upper limb which is sterile, should be easily manipulated. A supraspinatus-transacromial and transdeltoid approach is chosen. The superior trapezius muscle is sectioned 1 cm from its insertion on the spine of the scapula over a length of about 6 cm. The osseous portion of the trapezius transfer is harvested using the oscillating saw from the medial part of the acromion, anteriorly from the site of the acromiotomy which has to be performed after flap harvest. The muscular fibers that insert on the posterior part of the acromioclavicular capsule are separated from the anterior part of the trapezius muscle over 5 to 6 cm. The deep aspect of the flap is separated from the underlying fat taking care to preserve the vascular-nervous pedicle. Two transosseous tunnels are drilled into the bony portion of the flap. The flap is held by means of two # 2 braided nylon sutures threaded in a U shape. The anterior suture is threaded through the anterior section of the flap up to its superficial aspect then runs through the anterior acromial tunnel. The other suture is threaded through the same bone tunnel up to the surface of the flap then through the posterior bone tunnel. The flap is passed under the distal portion of the clavicle thinned lateraly with regard to the coraco-clavicular ligaments. The coraco-acromial ligament is maintained into place. The torn part of the subscapularis (tendon and muscular fibers) is resected up to the glenoid. The upper limb is placed in antepulsion and slight internal rotation, then the osseous part of the flap is fitted into a vertical trough created into the lesser tubercle just medially from the intertubercular groove. The trough starts 5 mm below the humeral head cartilage and its size corresponds to that of the osseous part of the flap. The flap which surrounds the humeral head superiorly and anteriorly is stabilized by the knot of the two U-shaped nylon sutures tied over the lateral aspect of the greater tubercle after being passed through three bone tunnels created from the bottom of the trough of the lesser tubercle. The hiatus located between the flap and the supraspinatus is closed by suturing the coraco-humeral ligament which is pedicled on the supraspinatus and desinserted from the coracoid process. Sutures without tension of the supra and infraspinatus are made through the supraspinatus-transacromial approach after performing a musculo-tendinous advancement when necessary [14]. The osteotomized acromion is reduced. Reduction of the acromion is maintained by means of two titanium cortical screws of 3.5 mm diameter inserted in a posterior to anterior fashion and tightened with compression (Fig. 2). Then the deltoid is closed.

During the postoperative period, the upper limb is maintained with a splint in approximately 30° of lateral elevation within the plane of the scapula. Passive mobilization within the plane of the scapula with 0° of rotation is initiated on the first postoperative day. From the 28th postoperative day, active assisted mobilization is initiated. Passive and active rotations are progressively increased. The splint is removed after a period of about 40 postoperative days. Rehabilitation is continued up to the 90th postoperative day with the assistance of a physiotherapist. Self-rehabilitation of the patient is maintained up to the 6th postoperative month.

Figure 2 Trapezius transfer associated with trans osseous suture of the supraspinatus. Final aspect.

Method

The functional and radiographic evaluation of shoulders

The functional status of the shoulders was assessed preoperatively and at a mean follow-up of 30 months (± 11.3) (range, 9 to 47 months) according to the non-weighted Constant score and its items [15]. Active external rotation arm at the side was also evaluated in degrees. A radiographic and CT-scan control was performed preoperatively and at a mean follow-up of 28.5 months (± 10 months) (range, 10 to 48 months). A/P radiographs in the sitting position and neutral rotation of the arm and axillary lateral views were used to measure the subacromial distance in order to assess the gleno-humeral arthritis status (according to the Samilson and Prieto [16] and Hamada et al. [17] classifications) and to evaluate grossly the anteroposterior centering of the humeral head on the glenoid. Horizontal CT scans obtained with soft tissue windows were used preoperatively and at last follow-up to assess the fatty muscle degeneration and fatty degeneration index [18—20] and achieve proper visualization of the trapezius transfer extremity in the lesser tubercle (Fig. 1). CT-scan obtained with bone windows were used to grossly identify the anteroposterior centering of the humeral head in the supine position, arm at the side. The anterior subluxation of the humeral head was confirmed on axillary lateral views and/or on CT scans.

Table 1 Mathematical formulas for calculation of non-weighted Constant (Cst) score using preoperative and final fatty degeneration index values.

	Regression linesCst score/preoperative FDI	Regression linesCst score/Revision FDI
Non-weighted Cst score	87,3 − (11,7 × FDI)	96 − (15,2 × FDI)
Pain (Cst)	14,1 − (1,4 × FDI)	15 − (1,7 × FDI)
Mobility (Cst)	40 − (3,8 × FDI)	42,5 − (4,7 × FDI)
Strength (Cst)	14,3 − (4,7 × FDI)	17,6 − (6 × FDI)

Comparison between the last follow-up Constant scores and ''the theoritical estimated Constant scores''.

The last follow-up Constant shoulder and item scores were compared with the ''theoritical estimated scores'' [20] which would have been obtained after anatomically successful sutures of the supra and infraspinatus with no associated trapezius transfer for subscapularis repair. The ''theoretical estimated scores'' were obtained by means of the mathematical formulas [20] (Table 1) used for the elaboration of regression lines which provided the postoperative Constant scores and item scores according to the preoperative FDI values. These regression lines had been acquired during the study of a series including 29 shoulders which torn rotator cuffs had become watertight after suture repair [21]. The mean preoperative FDI of this series (1.45) had to be recalculated (''corrected FDI'') [20] to take into account the non-repair of compete or quite complete subscapularis tears (as it was found in 18 out of the 20 cases of the series) by attributing to the subscapularis a fatty muscle degeneration score of 3 whatever its value on the preoperative scan. Therefore, we considered that a muscle with such tendon tear is an inactive muscle which could be compared to an inefficient muscle (FD over 2) with intact tendon [17]. The preoperative corrected FDI was 1.8.

Statistical analysis

The statistical analysis was performed using the Student *t* test and the regression curves (Anova table). Data were analyzed with the Statview® 4.55 software (Abacus Concepts Inc., Berkeley, CA, US). The threshold whereby the *P* value was considered statistically significant was set to 0.05.

Results

In one case, an infectious hematoma was successfully treated by surgical evacuation and adapted antibiotherapy. Asymptomatic non-union of acromiotomies was reported in four cases.

Constant score and radiographic evolutions

The evolution of the Constant score and its items as well as the radiographic evolution between the pre- and postoperative periods are detailed in Tables 2 and 3 respectively. Pain, daily activities and Constant score had statistically improved ($P = <0.0001$, 0.0001 and 0.0002 respectively). All other items and sub-items of mobility of the Constant score, except internal rotation, had improved but only external rotation had statistically improved. However, active external rotation arm at the side seemed to have deteriorated: 51.8° in the preoperative period and 42.3° postoperatively ($P = 0.0583$).

The subacromial distance did not demonstrate any statistical modification and remained high. According to the Samilson and Prieto classification, arthritis had statistically worsen whereas it was not aggravated according to the Hamada et al. rating system. There was no statistical improvement of the anterior subluxation of the humeral head which had reduced only four times. The long head of the biceps which was present 17 times preoperatively, was only visible in nine cases on postoperative arthro CT-scans.

Table 2 Functional evolution using the non weighted Constant score (Cst) between the preoperative and the 30-month follow-up status (range, 9 to 47 months) for the 20 studied shoulders.

	Preoperative	30-month follow-up	*P*
Pain (Cst)	6.35 ± 1.9, (3—10)	11.15 ± 1.9, (8—14)	< 0.0001
Daily activity (Cst)	10.1 ± 4.1, (2—17)	15.15 ± 2.8, (11—19)	0.0001
Mobility (Cst)	27.6 ± 9.4, (8—38)	29.8 ± 4.8, (22—38)	0.255
Lateral elevation	6.6 ± 2.6, (2—10)	7.3 ± 1.6, (4—10)	0.263
Anterior elevation	6.9 ± 2.4, (2—10)	7.1 ± 1.4, (4—9)	0.677
External rotation	7.1 ± 3.6, (0—10)	9.2 ± 0.8, (8—10)	0.0118
Internal rotation	7 ± 2.4, (2—10)	6.2 ± 2.5 (2—10)	0.166
Strength (Cst)	6.45 ± 3.2, (2—14)	7.3 ± 3.6, (3—15)	0.4157
Non-weighted Cst score	50.45 ± 12.5, (29—71)	63.4 ± 7.9, (51—78)	0.0002

Table 3 Radiographic evolution between the preoperative and the 28.5-month follow-up status (range, 10 to 48 months) of the 20 studied shoulders.

	Preoperative	28-month follow-up	p (pre/postoperative)
Subacromial distance (mm)	8.3 ± 2.2, (5–12)	8.75 ± 2, (5–12)	0.3692
Gleno-humeral arthritis according to Samilson et al.			
Stage 0	12	8	0.04
Stage 1	6	11	
Stage 2?	1	1	
According to Hamada et al.	1		
Stage 1	15	16	0.66
Stage 2	5	4	
Anterior subluxation of the humeral head			
Yes	11	7	0.27
No	9	13	
Fatty degeneration			
of the supraspinatus	1.1 ± 1.1, (0–3)	1.6 ± 0.7, (1–3)	0.002
of the infraspinatus	1.2± 0.7, (0.5–2.5)	1.6 ± 0.5, (1–2.5)	0.0018
of the subscapularis	2.1 ± 1, (0.5–4)	2.9 ± 1.1, (0–4)	< 0.0001
Fatty degeneration index (FDI)	1.45 ± 0.6, (0.3–2.6)	2 ± 0.5, (0.7–2.8)	< 0.0001

±: standard deviation; (): extreme values.

The aggravation of fatty muscle degeneration was statistically confirmed (it was higher for non-sutured subscapularis) thus leading to a significant increase in the FDI. The termination of the flap on the lesser tubercle was still visible on CT scans (Fig. 1).

Despite the possible relationship that could be made between postoperative improvement of pain and function, no correlation could be established between pain improvement and daily activity ($P = 0.3973$), mobility item of the Constant score ($P = 0.7268$), strength ($P = 0.1227$) and Constant score ($P = 0.1213$) improvement. Postoperative improvement of the functional status could be partly attributed to the repair of rotator cuff tears.

Comparison between scores

The comparison between the mean Constant score (and its items) at last follow-up of the study and the ''theoretical estimated scores'' obtained in the absence of subscapularis treatment is detailed in Table 4. Quotations appeared similar for residual pain. However, the use of a trapezius flap provided a less satisfactory mobility (−3, 4 points), a slightly higher strength (+1.5 points) and a slightly inferior non-weighted Constant score (−2.8 points) (Table 4).

Discussion

The studied series gives the functional and radiographic results of a series of 20 repairs of full-thickness rotator cuff tears involving the subscapularis in all cases. A trapezius transfer was used for reconstruction of subscapularis full-thickness ruptures which were complete or quite complete in 18 cases and irreparable in all cases. Associated ruptures of the supra and infraspinatus were all sutured without tension. All rotator cuff tears had become watertight on arthro CT-scan control performed at a mean follow-up of 13.5 months. The functional results were obtained at a mean follow-up of 30 (± 11) months. Compared with the preoperative status, only pain, daily activity, external rotation according to the Constant score and Constant score had statistically improved. However, the internal rotation according to the Constant score and active external rotation arm at the side had deteriorated. Moreover, preoperative anterior subluxations of the humeral head had not been reduced.

The small sample of patients and the short follow-up period of this series may appear as limitations. But other series published in the literature which assess the functional outcome according to the Constant score with use of a

Table 4 Comparison between the obtained (using the trapezius transfer) and the ''theoretical estimated'' (without treatment of the subscapularis tear) Constant scores (infraspinatus and supraspinatus tears were treated successfully in both cases).

	Obtained quotations	''Theoretical estimated'' quotations
Constant score (Cst)	63.4	66.2
Pain (cst)	11.15	11.6
Mobility (cst)	29.8	33.2
Strength (cst)	7.3	5.8

Table 5 Series published in the literature describing a pectoralis major transfer for irreparable tears of the subscapularis.

	Jost et al. [7]	Resch et al. [6]	Hackl et al. [8]	Elhassan et al. [9]	Gavriilidis et al. [10]
Number of cases	30	12	23	11	15
Mean age at surgery (years)	53	65	<60	58	62
Mean follow-up (years)	2.7	2.3		4.8	3.1
Treated tears					
Isolated subscap tears	12	8	10		
Subscap + supraspin	13	4	13		15
Subscap + supraspin. + infraspin	5			11	
Non-weighted					
Constant score	62	54.4	68	52.3	68
Pain	9	9.6			14
Mobility					34.2
Strength	7	4			3.3

pectoralis major transfer in the treatment of irreparable tears of the subscapularis [6—10] report a similar (Table 5) number of cases and postoperative follow-up period. The anterior subluxations of the humeral head have been grossly evaluated which may also appear as a limitation. However, the axillary lateral view is non reproducible (the position of the upper limb is not clearly defined) and position of the humeral head relative to the glenoid on CT-scans may be modified when resting or not on the table [22].

The difficulty is to assess the role of the trapezius transfer in the improvement of the non-weighted Constant score, pain, daily activity, mobility (except for internal rotation and external rotation arm at the side) and strength relative to the preoperative status which could be only attributed to the successful sutures of associated tears of the supra and infraspinatus. In fact, postoperative pain and strength reported in this series are comparable to the ''theoritical estimated'' pain and strength status achieved after successful suture of associated tears of the supra and infraspinatus without treatment of the subscapularis rupture. Moreover, in this series, mobility according to the Constant score is inferior to the theoretical estimated mobility. Therefore, it may appear that use of the trapezius transfer does not lead to pain and strength improvement and that it may be associated with a loss of mobility. The postoperative decrease in internal rotation is probably induced by the mechanical contact occurring between the extremity of the trapezius flap (Fig. 1) and the anterior border of the glenoid. The decrease in active external rotation arm at the side is certainly induced by the tension applied to the flap. This decrease in active external rotation contrasts with the improvement in external rotation according to the Constant score which is probably induced by the improvement in active lateral and anterior elevations of the shoulder. The use of a trapezius transfer thus appears functionally useless. Moreover, it seems unable to reduce preoperative anterior subluxations.

The functional outcome of this series is comparable to that reported in series using a pectoralis major transfer [6—10] (Table 5). Is the pectoralis major transfer as functionally useless as the trapezius transfer? Unfortunately, in most series, the ''theoretical estimated'' scores cannot be calculated: the preoperative fatty muscle degenerations and the anatomical success rate of supra and infraspinatus sutures remain unknown. However, in two series, that of Gavriilidis et al. [10] and a subseries from the Jost et al. series [7], the ''theoretical estimated'' scores may be approximated. The Gavriilidis et al. series (Table 5) includes 15 irreparable tears of both the subscapularis and supraspinatus with intact tendino-muscular infraspinatus. The corrected FD score of non-sutured subscapularis and supraspinatus is 3. The preoperative FD score of the intact infraspinatus would be 1 at the worst. The corrected FDI would thus be 2.3 at the worst. The subseries of Jost et al. (Table 5) included 12 irreparable and isolated tears of the subscapularis. Only the postoperative weighted Constant score was reported. The preoperative FD scores of the intact supra and infraspinatus would be 1 at the worst and the corrected FD score of the non-sutured subscapularis is 3. The FDI would be 1.7 at the worst. In both series, the absence of pectoralis transfer would correspond to a non-reparative surgical treatment. Calculation of the ''theoretical estimated'' scores should be based on the mathematical formulas which were used in the construction of regression lines, postoperative Constant scores/FDI at revision [21] (Table 1). In the series of Gavriilidis et al., the ''theoretical estimated'' mobility and strength values would be comparable to those obtained by the authors (31.7 vs 34.2 points and 3.8 vs 3.3 points respectively). However, the ''theoretical estimated'' residual pain (11.1 points) would be inferior to that obtained by the authors (14 points), but such indolence has never been reported in other series. In the subseries of Jost et al., the ''theoretical estimated'' Constant score would be 70.2 points whereas the non-weighted score, calculated from the weighted score reported by the authors, reaches 70.4 points. Therefore, the use of the pectoralis major transfer also appears as functionally useless.

Conclusion

The trapezius transfer which reports comparable results to those achieved with a pectoralis major transfer, does not appear as a functionally useful treatment option. Moreover, it does not seem to prevent glenohumeral arthritis degradation since in most cases, the preoperative anterior subluxation of the humeral head persisted in the mid-term. We thus advocate the use of a trapezius transfer only when less aggressive, non-reparative medical and surgical treatments failed to improve pain.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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